

ART. LIV.—*Air and Water Poisoning in Melbourne.*

By SYDNEY GIBBONS, F.C.S., etc.

[Read 22nd November, 1869.]



**N** some important subjects connected with the public health as it is affected by sewage and water supply, and by their effect on the atmosphere, I have made some observations and experiments, which I propose to lay before the Society in the present paper. The subjects are so intimately connected, that, divide them how we will,

the divisions will have much in common, and it will not be easy to avoid a little iteration. Perhaps it will be best to adopt the two headings already noted, viz. : Sewage and water supply, as main lines, and to digress from the one to the other as occasion may require.

## PART I.

## CITY SEWAGE.

During the last year (1868), when the city health officer (to whose activity we are already so much indebted) was exerting himself to reduce in some degree the evils to which we are exposed by our system, or rather no-system of disposing of sewage, he found that in many places excrementitious matters were systematically discharged into the street channels. Powers exist by which the offenders can be punished, and the practice stopped when detected ; but the contrivances employed frequently baffled the inspector, and no wonder ; for the work was generally done at night, there was seldom any external indication, and even if observed in the day-time, a certain conclusion could not always be arrived at. The plan, which is called "flushing," consists in turning a waterpipe into the cesspit, which is then connected with the common drain. It is obvious that by using a large amount of water the materials are so masked that they cannot be recognized, and it was often necessary to break up drains and to enter houses in order to detect the arrangement. A few places had long been suspected, but at the time of these experiments it was

found to be a growing practice to build houses with drains and pipes of this kind ; and the double offence of wasting water and turning the street into a cesspit, or the cesspit into the street, was common and familiar. The labour was in finding out the cases, and in watching the offenders afterwards to see that they did not recur to the practice, as was often done.

But still greater difficulties were presented by a refinement which stood *in loco parentis* to the practice just described. I allude to the filtration system, of which Dr. Tracy was the apostle. This gentleman (and others who adopted the plan) professed, and no doubt believed, that it fulfilled all the required conditions. How they could possibly arrive at such a conclusion it is difficult to conceive ; and it may be doubted if many who adopted the method troubled themselves with any view at all. But Dr. Tracy publicly recommended it as efficacious, and spent much money in fitting up his own ; and it was also introduced into a public institution where he holds a prominent position. The existence of filters, examples of which were tolerated for a time, encouraged the construction of others, and what was still worse, furnished to many persons a pretext for flushing, under the pretence of filtering.

In view of all these and other difficulties that beset the endeavour to stop these practices, the City Health Committee did me the honor to desire an investigation and report upon the several branches of the subject. The experiments made and observations recorded while carrying out these instructions are embodied in the present paper.

After conference with the health officer, I visited, at different times, several places that required examination in connection with this subject, in order to select and obtain the necessary samples for analysis.

Instead of limiting myself to the examination of a number of samples to be furnished to me, I preferred visiting the places myself, and when doing so, took a large number of samples, and made such use of each as I deemed judicious for the advancement of the objects in view, viz. :—

First. The determination of the efficiency or non-efficiency of the filtering system of cesspit draining ; and secondly, the detection of sanitary evils which, not being detectable by ordinary methods, did not come under the common description of nuisances.

I do not therefore confine myself here to the bare state-

ment of the existence of fæcal matters in the fluid which had passed through the filters; but add to my notes on that head some other matters intimately connected therewith, and bearing on the conditions which follow the discharge of this liquid into the street channels.

It is not necessary to record all the inspections; the places finally selected, and the samples taken are as follow:

- I. Miers' Bakery, 203 Bourke-street west.
- II. Dr. Tracy's filter.
- III. Lying-in Hospital filter.
  - a. A filter at 11.30 a.m. before communicating with the officers of the establishment.
  - b. 1 p.m. after notice.
  - c. Liquid from surface of opened filter.
  - d. Contents of cesspit liquid.
  - e. " " " " solid.
- IV. Street gutter, Elizabeth-street, west side, south of Little Collins-street.
- V. Street gutter, Swanston-street, east side, south of Bourke-street.
- VI. Gully in Fitzroy Gardens, draining Albert-street and Victoria Parade.
- VII. Yan Yean water from service for comparison.

Before going into further particulars I make the following notes:

*Case I.* The liquid taken from Miers' was extremely foetid. It oozed from a crevice on the wall abutting on a right-of-way. It contained fæcal matters, but as I afterwards learned that, on examination of the interior of the premises, it was found to proceed directly from the overflow of a cesspit under the foundation and not from a filter, I may economise space by omitting further mention of it.

*Case II.* Dr. Tracy courteously assisted us in making the requisite inspection, and explained the arrangements of his filter, which, on the hypothesis that the system was effectual, appeared to be complete and well-planned. It may be worth while to expend a brief space in describing these arrangements. The water-closet was supplied by Yan Yean service and by the bath water of the house, to the exclusion of kitchen slops. The cesspit, at a short distance from the closet, was a large stone chamber furnished with an iron

grating, and a partition wall dividing it into two parts except at the bottom. The dejecta were thus comminuted by the force of the stream of water beating against the partition wall and the grating, so that before they reached the filter the whole was a homogeneous liquid. The filter, at the bottom of which the mixture entered, was a covered pit with an iron grating at a short distance above the bottom and another near the top. Between the two were layers of road metal, oyster shells, and charcoal, both animal and vegetal. This constituted the filtering material. Its effect remains to be considered.

*Case III.* The next place visited was the Lying-in Hospital, from which several samples were taken at different times, and under different circumstances. The first step was to take a sample of the water flowing from the filter drain before the object of the visit was announced. It was well that this step was taken, for on subsequent visits made by appointment, a much larger flow of water was observed, and also the presence of a quantity of chloride of lime. Here the opportunity was afforded us of seeing the inside of the cesspit and filter, which were obligingly opened for the purpose. Here were wanting the breaking diaphragm and grating already described under No. II., consequently, the comminution was not so complete, and took place more slowly. Added to this difference, is the fact that the kitchen slops flowed in on the top of the cesspit, and with its contents passed through the filter, where the presence of any grease was of course prejudicial. The samples taken here were five in number, and were variously used in the course of the experiments, the most important observations being made with No. A. After the completion of the experiments, I went to the place alone a little before midnight. Abundance of water was flowing from the filter, and an offensive smell, of which no other source appeared than the gutter, was distinctly noticeable.

*Case IV.* It was considered, both by the Health Officer and myself, very desirable to examine some of the waters flowing in the street channels, although they did not come under my official instructions. Accordingly, the Inspector of Nuisances was directed to supply me with a sample, which he took in Elizabeth-street at 11 p.m. I had myself observed a disgusting stench proceeding from a gutter in Bourke-street near the Theatre Royal on the same evening, and with

the desire to add to my store of material and of information, I sallied forth with the Inspector after midnight, and inspected several places, including various premises in and off Bourke-street. One of these deserves to be mentioned, as it contributes largely both to the flow of water and to the too familiar stench of Bourke-street east. It was the public-house called the "Australian Felix," at the N.E. corner of Bourke and Russell-streets. At the time of this visit the bilge was being pumped out, and the smell was so disgusting and so strong, that at a short distance it might have been mistaken for that arising from the operations of nightmen. I do not know the internal arrangements of the premises in question, but a great part of the nuisance is easily explicable. The cellarage of this house is the lowest point in a thickly peopled block, containing some of the veriest hovels that disgrace the city. The water and filth, faecal and otherwise, with which the soil is saturated, percolate the ground into these cellars, from which the pestiferous liquid is nightly pumped into the street.

*Case V.* The sample which I took on that occasion for the purpose of examination was from the gutter in Swanston-street on the east side, and south of Bourke-street. This gutter drains nearly the whole of Bourke-street east, and the blocks lying to the north of it. It affords therefore, a good sample of genuine sewage of a populous district, and it was studiously taken at a point where no individual interest was immediately concerned, as I wished it to illustrate the general question.

*Case VI.* After this was finished, and when I was about commencing to draw up my report, the Health Officer drew my attention to a serious evil existing in Fitzroy Gardens, where an open sewer, for it is nothing else, traverses this popular place of resort. It is not generally known, but ought to be published, that the gully running through the Gardens from north to south, and forming in its route what have been humorously termed the Fallah Falls, is nothing more nor less than the sewer draining a portion of the Victoria Parade, but more particularly the blocks on the south side between that thoroughfare and the Gardens. The occasion of our visit appeared to be a general washing day, and the character of the liquid was masked by soapsuds; but the sample brought to me by the serjeant on a Saturday evening, when it was assumed to be free from such adventitious dilution,

was very fetid and betrayed its origin even to the unaided senses.\*

*Case VII.* In order better to determine the quantity and nature of the matters added to the water in its passage through the filters, cesspits, and other places whence the samples proceeded, it was desirable to make a similar examination of the Yan Yean water. This step was also a necessary precaution to take, lest, in the event of any legal proceedings being undertaken, the absence of such information might cause a case to fall through, as an advocate in defence might pretend that the matters detected existed in the water supply. It was therefore essential to be provided with the means not only of declaring that the noxious agents and indications of decomposition hereinafter to be described, did not exist in the Yan Yean water, but also of distinguishing between the organic inhabitants of that water and those found in the samples examined. I also examined the water of the Yarra, taken within the town boundary, but before receiving the sewage.

I now proceed to enumerate in order the results obtained from each of the principal samples examined, noting the following particulars.

The residues of both kinds estimated quantitatively.

The products as indicative of decomposition and of the presence of excrementitious matters.

The character of the microscopic organisms contained.

In these analyses, I determined the comparative amounts of solid residue, of organic and inorganic matter, for the purpose of contrasting them with each other and with the Yan Yean water, which in every instance formed the bulk of the fluid. For the detection of *faecal* matters, &c., I relied chiefly on the presence of nitrogenous compounds already in solution, as ammonia and nitric acid, or in the form of albuminoid substances yielding nitrogen by decomposition; on the evolution of sulphuretted hydrogen and carbonic acid; and also on the character of the vegetable and animal bodies revealed by a searching microscopic analysis. All the samples were allowed to settle for a sufficient time before examination, so that grit and other heavy inconsequential substances were eliminated.

---

\* At the date of this paper, the gully also received the sewage of the Government Printing Office.

*Case II. (Dr. Tracy's.)*—Characters. Clear, only a whitish turbidity, and that but slight, no conspicuous odour at first.

Residue per gallon	- -	18.016 grains.
Non-volatile organic matter		6.240 „
Inorganic	- - - -	11.776 „

It contained sufficient decomposing and decomposable animal matter to yield marked reaction of carbonic acid and ammonia. Sulphuretted hydrogen was readily evolved.

The microscopic examination yielded specimens of the following organised substances, plants, and animals. The liquid soon settled clear, and a film gradually appeared at the top. The fungi grew in clusters at the bottom.

Fibres of flax, &c.; fragments of vegetal tissues, various.

Confervæ; filaments of mucedinous fungi (abundant), which grew rapidly on standing; Desmids, cosmarium tetra-ophthalmum; sporangia, various.

Acarus (only one seen, dying); query acarus dysentericæ; rotifer vulgaris many; kolpoda; paramecium; bursaria many; loxodes, very abundant in the film which appeared on the top; trichodiscus with ova; dileptus; monads, various.

See Photograph, Plate II., fig. 1.

*Case III. (Lying-in Hospital.)*—Most of the experiments were made with the sample A, but some of the characters of the others were also noted. The liquids were at first nearly clear, with a little sediment, but large clusters of fungi soon appeared, with the odour of decomposition. Some solid matters were found which had escaped through the channels in the filter. (One piece apparently a lump of fat meat (undigested) measuring  $\frac{3}{4} \times \frac{3}{4} \times \frac{1}{2}$ -inch was preserved for illustration.) It contained—

Solid residue, per gallon	- -	9.120 grains.
Fixed organic matter, do.	- -	2.560 „
Mineral matter, do.	- - - -	6.560 „

It yielded carbonic acid, ammonia, and sulphuretted hydrogen, and the same general conditions obtained which have been detailed under No. II. The microscopic examination detected the following organisms:

Fibres of cotton, confervæ, mucedinous fungi, spores, monads, various.

Desmids—*Micrasterias furcata*, *staurastrum Dickiei* and



Fig. 1.—YAN YEAN, 1858.— $\times 250$  diam.



Fig. 2.—YAN YEAN, 1868.— $\times 125$  diam.



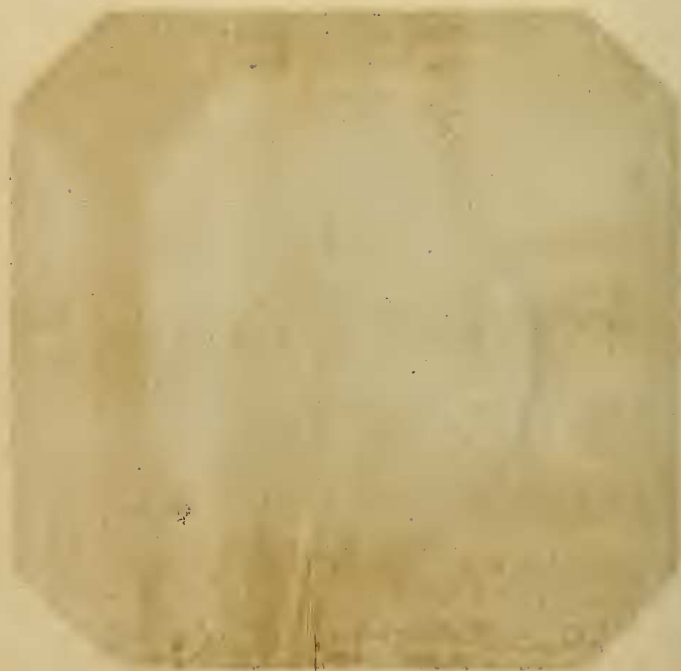
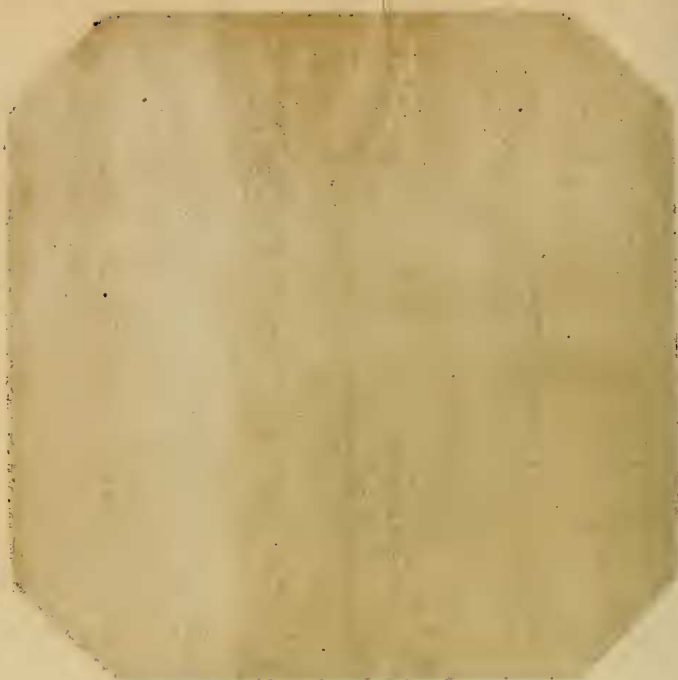




Fig. 3.—MELBOURNE SEWAGE.— $\times 125$  diam.



Fig. 4.—MELBOURNE STREET GUTTERS.— $\times 125$  diam.



paradoxum, docidium Ehrenbergii, arthrodesmus sp., closterium intermedium.

Rotifer vulgaris, many; anguillulæ (mostly dead in A, but very abundant and lively in another sample), paramecium abundant, bursaria, euplotes, kolpoda, vorticella microstoma, acineta or podophrya, loxodes, peridinium, leucophrys.

*Sample V. (Swanston-street gutter.)*—Turbid, depositing much earthy and other suspended matter, which was disregarded, smell filthy and faecal. (The Elizabeth-street Sample IV. had similar characters, but less strongly marked.)

Solid residue, per gallon	- -	43·680	grains.
Fixed organic matter, do.	- -	11·120	„
Inorganic matter, do.	- - -	32·560	„

The evidences of the presence of carbonic acid, ammonia, and sulphuretted hydrogen were very decided.

The microscopic objects contained were as follows:

Vegetal tissues various, woody fibre, hair decaying, mucedinous fungi, confervæ, desmid, staurastrum brevispinum, vorticella microstoma, uvella abundant, bursaria, trepomonas, monads various, disoma many, enchelys, astasia bodo, leucophrys, trichoda angulata, paranmecium, kolpoda.

See Photograph, Plate II., fig. 2.

*Sample VI. (Fitzroy Gardens gully.)*—General characters as the last sample. Very foetid and turbid.

Solid residue, per gallon	- -	28·368	grains.
Fixed organic matter, do.	- -	10·880	„
Inorganic matter, do	- - -	17,488	„

Carbonic acid, ammonia and sulphuretted hydrogen strongly marked; sulphurous acid was also found.

The microscopic matter was similar in character to the last sample; most of the same organisms and fragmentary structures being found.

*Sample VII. (Yan Yean water from service.)*—Clear and sweet, very minute bright green deposit on long standing, the water being then quite bright.

Solid residue, per gallon	- -	8·736	grains.
Organic matter, do.	- - -	2·152	„
Inorganic matter, do.	- - -	6·584	„

No ammonia or sulphuretted hydrogen.

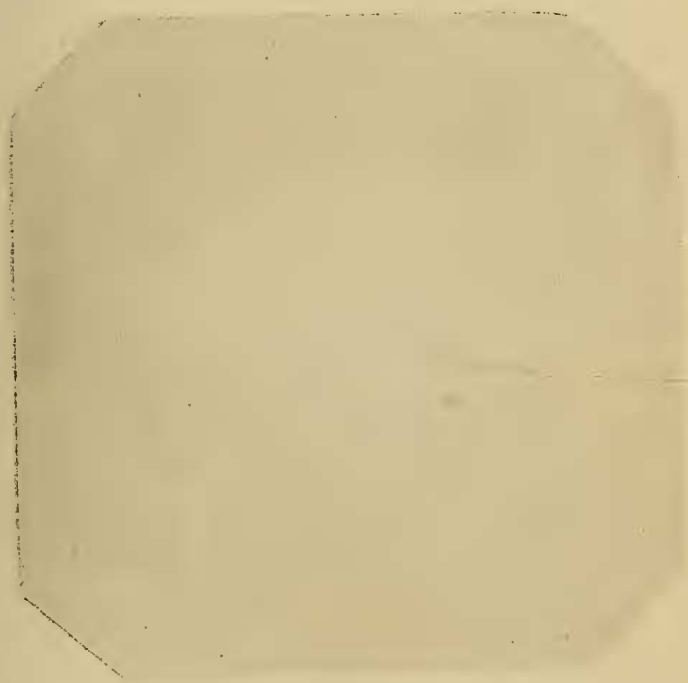
The suspended organic matter as shown on microscopic examination consisted entirely of those plants and animals which live in pure water, viz.:—Monads, rotifers.

Desmids, micrasterias furcata and pinnatifida, staurastrum gracile, paradoxum and orbiculare, arthrodesmus incus, docidium qy. truncatum, &c.

There were no fungi or confervæ of any kind, and the absence of all animalcules of the kolpod group was also marked.

I proceed now to collate these results, and to consider how far they afford material for arriving at definite conclusions relative, first to the efficacy or value of the filtration cesspits (the principal question submitted to me), and afterwards to some points bearing on the relation of the present system of drains and cesspits to the public health, as illustrated by this investigation.

Two filters were examined, and one of them (the largest) was sampled several times. It was also opened, that its internal arrangements might be seen, and their condition and operation noted, as I had reason to doubt whether, in the strict sense of the term, it was a filter at all, or only a strainer. The suspicion that it was chemically inoperative, and mechanically incomplete, was fully borne out. Pieces of solid matter, meat, were seen proceeding from it, and one of them which, when moist, was as large as a filbert was preserved. It appeared that the current of water had worked channels through the whole body of the filter. These channels were many in number, and the water flowing through, carried with it portions of the charcoal of which the filter was in part composed, and there was a layer of this charcoal on the top of the upper grating, outside the filter, which was said to be composed of 6 cwt. animal charcoal, 12 bags wood charcoal, and 1 load of oyster-shells, with a layer of road-metal at top and bottom, the whole enclosed by the two iron gratings. A stick was inserted and easily stirred about for a depth of a foot in the filter, showing its disintegration. The cesspit in connection with this filter (the lower one) received, in addition to the contents of the closets, the washings of the kitchen. I was informed that the present filter (III) was relaid 18 months before the examination, and that when it was then opened the cesspit only contained  $3\frac{1}{2}$  feet deep of solid matter, representing the excreta of sixty or seventy persons! At the time of the present inspection the rough test of taking



COLOURING MATTER

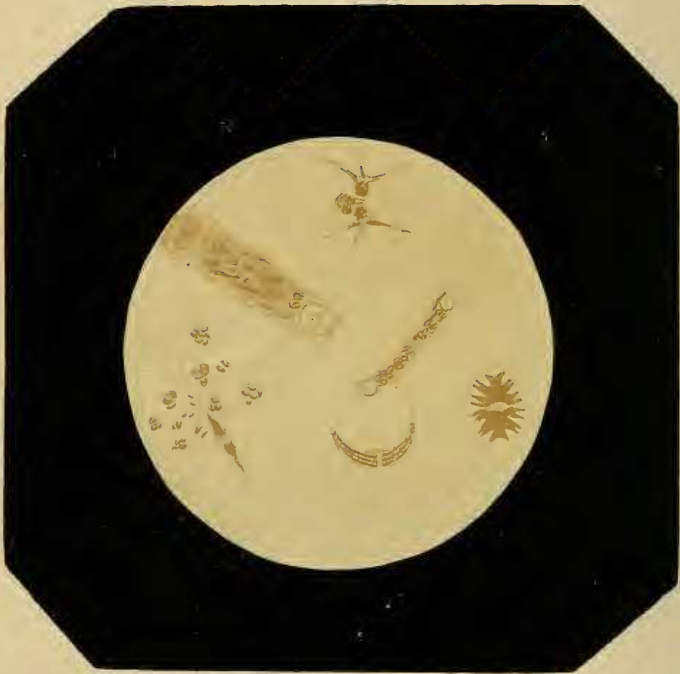


Fig. 5.—DESMIDIÆ—PRINCIPAL FORMS IN YAN YEAN.  
× 250 diam.

soundings with a tin vessel attached to a pole led to the conclusion that not more than 3 feet of solid matter lay at the bottom, and it may be doubted whether there would have been so much if the apparatus had been fitted with the disintegrating contrivance which has been mentioned as forming part of Dr. Tracy's filter. I should mention here that portions of solid excrement were seen in the street channel adjacent to and below the outlet of the filter drain. These were not actually seen by me to proceed from the drain, but whether they did or not is of little importance; they might easily have done so. Such matters are not likely to be efficiently arrested by an arrangement which allowed free passage to lumps of solid meat as large as filberts. The small amount of solid matter left behind showed plainly that enormous quantities had gone through, and that in fact the filter was no filter at all; it was a mere strainer which only delayed the passage of the excrementitious matters until they were sufficiently broken up to pass through the blowholes. In a newly-laid filter, before these blowholes are formed, the contents of the cesspits require to be completely comminuted before they can escape, for the mass has to be reduced to the state of a liquid in which the insoluble particles are so finely diffused as to simulate solution; and this appeared to be the case in Dr. Tracy's, which was better constructed, but even then I learned that the amount left behind was very small. That this comminution does take place, even with the more refractory paper and rags, is plainly shown by the abundance of cotton and flax fibres and other vegetal tissues found, on microscopic examination of the clear colourless water that passes off. The escaping matters are frequently masked to the senses of sight and smell by the immense volume of water in which they are suspended. A stream of water was constantly flowing, and on occasions when inspection was made by appointment the flow was much stronger. Thus, then, the filtering process appears to fail of its object, even if regarded solely as a mechanical agent. A larger proportion of the solid matter becomes soluble as a result of fermentation and decomposition, and the question only appears to be whether it shall undergo a part of this change in the primary receptacle, in the streets of the city under the noses of its inhabitants, or in the river, which exhales its fogs and vapours fraught with the volatile portions of the filth that is poured into it.